being merely reproductions or duplicates of those already photographed? A partial answer to this query seems to be indicated by the vast number of new patterns that were obtained from the past winter's storms, greater than any previous single winter has furnished. This fact, coupled with the certainty that the number of individual crystals that go to form the snowfall of even one storm, is so vast that one, or many observers, may never hope to find and see anything more than an absolutely insignificant fraction of the whole, leads us to the conclusion that, during all future time and so long as there shall be observers to search for them, new designs will continue to be found to delight the eye with their beauty.

Another interesting thought that arises is: That it is extremely improbable that anyone has as yet found, or, indeed, ever will find, the one preeminently beautiful and symmetrical snow crystal that nature has probably fashioned when in her most artistic mood.

In closing, it seems hardly necessary to add that this most charming and delightful branch of nature study is as yet at its beginning; it still possesses the charm of novelty; many of its problems are unsolved, and many will find its pursuit a source of great pleasure and instruction.

CORRIGENDA.

On page 397 of the MONTHLY WEATHER REVIEW for August, 1902, below the title of the article on "Ocean Currents," insert "Reprinted with slight changes, from pages 135–142 of the National Geographical Magazine.

REPORT OF THE CHIEF OF THE WEATHER BUREAU FOR THE FISCAL YEAR ENDING JUNE 30, 1902.

Dated October 15, 1902.

I have the honor to submit a report of the operations of the Weather Bureau during the fiscal year that ended June 30, 1902.

FORECASTS AND WARNINGS.

The most important tropical storm of the year appeared first as a feeble disturbance in the subtropical region north of Cuba August 9, 1901. It advanced thence over the southern part of the Florida Peninsula during the 10th and 11th, and recurved westward over the Gulf of Mexico by the morning of the 12th. Moving westward the storm increased greatly in intensity during the 13th and 14th, and during the 14th and 15th it recurved northward over the Louisiana coast, attended by gales of hurricane force. Warnings in connection with this storm were begun on the 10th. The estimated damage to property along the Louisiana coast amounted to over $1,000,000, and according to the estimate of the secretary of the Mobile Chamber of Commerce the value of property saved by the warnings of the Weather Bureau aggregated several millions of dollars.

The North Atlantic and West Indian forecast and storm-warning service was continued in successful operation during the year. Forecasts, for the first three days out, for the use of steamers bound for European ports were issued daily at 8 a. m. and 8 p. m.; American and European shipping interests were notified of the character and probable course of the more severe storms that passed eastward from the American coast.

The following letter, dated November 15, 1901, addressed by the secretary of Lloyd's, London, to the Chief of the United States Weather Bureau, at Washington, indicates the degree of interest that is being taken in the Weather Bureau warnings by representatives of the commercial and shipping interests of the North Atlantic:

I am instructed to express to you the best thanks of the committee of Lloyd's for the forecasts of bad weather in the Atlantic with which you have been so good as to allow them to be favored, and I am desired to convey to you the congratulations of my committee on the infallibility of the predictions that have been supplied by these forecasts.

On the morning of November 1, 1901, the following message was telegraphed to the Weather Bureau offices at Hamilton, Bermuda; New York, N. Y.; Philadelphia, Pa.; and Boston, Mass.: "Severe disturbance moving northward east of Turks Island will probably pass near Bermuda Saturday."

The following article from the Bermuda Colonist of November 6, 1901, verifies the accuracy of the advices furnished:

The hurricane that was predicted by the Washington Weather Bureau for Saturday arrived on time and raged around the islands for twenty-four hours. All the incoming steamers were delayed in consequence, and those that were southward bound, the New York mail steamers especially, experienced exceedingly heavy weather. The growing crops throughout the colony have suffered somewhat, and the storm damage to property has been considerable. The principal damage reported has been occasioned to government property about the islands in the Great Sound, where the prisoners of war are interned, and it is said that the preliminary estimate of the damage reaches the sum of £2000. Reports from the westward state that the contractors for the dock-yard extension works have also sustained some loss; a large boat used for conveying laborers and a large quantity of balk timber got adrift.

The first general frost-bearing cool wave of the fall of 1901 swept from the northeastern Rocky Mountain slope southward to Arkansas and Tennessee and eastward to the North Atlantic coast States, during September 17–20. Ample warnings were distributed throughout the districts visited by the frosts of the period referred to.

The cold waves of December, 1901, were exceptionally severe in the Lake region, the central valleys, and the Southern States. The following are among press comments made regarding these cold waves:

The cold-wave warning was issued fully thirty-six hours in advance of the cold changes; it was telegraphed to all the important towns of the State, from which points it was distributed by mail. It is learned that the information was posted in over 1500 places in the State yesterday morning, which demonstrates the very thorough and rapid system the Weather Bureau now has for getting such warnings before those who are actually interested.—*Montgomery (Ala.) Advertiser of December 10, 1901.*

There has been some injury in the citrus-fruit and winter-vegetable districts, but, thanks to the early warnings of the Weather Bureau, those who know how to burn and smoke as a preventive from frost effects saved much property and gave a new demonstration of the efficacy of the protective measures which have been brought to high development in California.—*Pacific Rural Press, San Francisco, December 17, 1901.*

The Weather Bureau gave ample notice of the coming of the cold wave, and its predictions have seldom been more accurate as to the extent of the wave, the territory that would be affected by it, and the degree of cold the thermometer would record; and this warning did much to prevent any serious damage to the cane crop from the freeze by giving the planters time to prepare for it.—*New Orleans Times-Democrat, December 17, 1901, editorial.*

Much credit is due the Pittsburg station of the United States Weather Bureau for its truthful and timely predictions in the recent sudden changes of weather in this section. Warnings far in advance of the first local intimation of a cold snap were sent to shippers of perishable goods, and thus much damage was averted that otherwise would have resulted. When the continuous rains and heavy snows set in, warnings were also sent out notifying property holders of the imminent danger of a flood.—*Pittsburg Post, December 16, 1901, editorial.*

The following warnings, telegraphed from Washington to Jacksonville for distribution in Florida, resulted in the protection of more than $1,000,000 worth of fruit, vegetables, and other property, and a direct saving of $540,000:

WASHINGTON, D. C., *December, 19, 1901.*

Center of low moving rapidly southeastward over Gulf. Minimum temperature to-night in central and north Florida will equal last night, and outlook is for lower temperature Friday night. All precautions against damage by cold justified for next two nights.

WASHINGTON, D. C., *December 20, 1901.*

Temperature will fall to about 20° at Jacksonville to-night, with temperature below freezing in the interior as far south as Jupiter. Emergency warnings, and notify postmasters.

The floods of the upper Ohio River in December, 1901, are referred to by the Pittsburg Gazette, of December 16, 1901, as follows:

The disaster to a large fleet of coal boats on the river last night is shown to be not chargeable to the weather service, which sent early warning of the coming of the high waters.

The destructive floods in the Appalachian Mountain streams during the closing days of February, 1902, were anticipated by the following warning, telegraphed February 23 from Washington to Weather Bureau stations in Pennsylvania and West Virginia for distribution:

Warmer weather indicated for the next two days, with conditions favorable for rain by Monday night. These conditions will be most favorable for a general breaking up of ice in the mountain rivers and streams of Pennsylvania, western Maryland, and West Virginia. Notify all interests concerned that danger from flood in low-lying land is imminent.

DISTRIBUTION OF FORECASTS AND SPECIAL WARNINGS.

Much attention has been given to the mail distribution of daily forecasts through the rural free delivery, and a substantial increase was made in this direction, although during the latter part of the year our efforts were greatly hampered by lack of funds for the purchase of the necessary supplies for carrying on this important work.

State or Territory.	At Government expense.			Without expense to the United States by					
								Telephone.	
	Daily forecasts.	Special warning only.	Emergency warning.	Mail, daily.	Rural free delivery, daily.	Daily telegraph service, daily.	Daily train service, daily.	Daily forecasts.	Special warning.
Alabama	29	6	152	900	857	31	12	15	28
Arizona	3	1	0	0	0	0	0	4	4
Arkansas	27	7	118	528	236	6	0	72	75
California	113	13	0	2,359	2,080	356	0	150	186
Colorado	19	17	81	359	1,201	2	7	4	23
Connecticut	14	4	52	979	2,225	12	151	3	0
Delaware	10	0	25	73	890	30	0	0	0
Dist. of Columbia	0	0	0	1,478	0	0	0	18	0
Florida	27	113	95	891	0	96	0	41	117
Georgia	40	37	268	1,568	2,045	141	41	26	348
Idaho	13	1	0	478	101	0	17	0	8
Illinois	117	28	524	3,424	7,196	127	459	175	711
Indiana	124	9	242	1,978	5,856	43	287	88	84
Indian Territory	8	0	5	154	0	0	0	0	0
Iowa	155	32	480	1,917	10,842	12	0	451	542
Kansas	66	8	217	808	3,802	29	15	3	0
Kentucky	39	37	102	1,928	75	21	0	400	407
Louisiana	24	37	71	735	125	0	0	11	49
Maine	23	5	46	1,569	1,920	0	77	3	18
Maryland	29	7	89	1,523	1,619	129	0	11	38
Massachusetts	25	22	71	3,647	2,770	0	331	16	61
Michigan	110	30	443	4,980	4,847	459	457	43	295
Minnesota	57	16	217	1,802	2,062	5	0	534	564
Mississippi	29	10	75	639	0	16	0	42	82
Missouri	102	11	280	4,204	7,323	31	0	558	323
Montana	21	3	24	638	0	0	0	12	19
Nebraska	63	12	241	1,087	1,777	0	0	37	81
Nevada	3	0	0	148	0	0	0	0	0
New Hampshire	18	1	39	682	2,730	0	31	0	0
New Jersey	29	27	127	1,181	255	176	0	40	34
New Mexico	5	2	0	15	0	7	0	7	30
New York	127	58	407	6,986	9,811	333	168	339	941
North Carolina	59	19	214	994	395	1	16	36	59
North Dakota	13	12	104	16	150	0	0	0	0
Ohio	145	92	407	7,812	22,381	38	17	1,456	4,609
Oklahoma	9	2	15	172	0	0	0	0	0
Oregon	20	2	0	795	745	0	104	0	3
Pennsylvania	68	23	345	3,922	200	827	0	1,967	768
Rhode Island	4	0	13	102	250	0	28	0	4
South Carolina	33	5	125	1,106	513	36	23	16	240
South Dakota	40	31	111	684	400	0	0	70	232
Tennessee	43	10	305	1,577	1,100	31	2	81	120
Texas	57	68	278	1,479	2,933	159	0	396	407
Utah	16	60	0	204	340	0	0	3	17
Vermont	11	1	50	598	175	9	13	1	1
Virginia	39	9	109	1,540	228	63	96	1,158	1,230
Washington	24	2	0	721	916	0	29	3	3
West Virginia	21	11	74	1,194	7	37	26	21	44
Wisconsin	69	16	447	1,802	1,733	1	16	40	66
Wyoming	6	4	8	90	40	16	0	1	1
July 1, 1902	2,146	921	7,096	74,327	105,161	3,280	2,423	8,297	12,872
July 1, 1901	1,958	985	7,096	*110,102	.....	3,280	2,423	8,297	12,872
Changes	188	- 64	0	.....	.....	.....	.....	.....	.....

* Including rural free delivery.

The preceding table shows the geographic extent of this work, as well as the increase over the distribution of the previous year:

There were in operation August 1, 1902, 10,025 rural free delivery routes, serving approximately 1,000,000 families, of which but 105,000 families (about 10 per cent), served by about 1000 routes, could be furnished with the forecasts of the Weather Bureau from the funds available for that purpose.

The Post-Office Department estimates that there will be in operation by July 1, 1903, 15,000 routes serving approximately 1,500,000 families. With the necessary funds it would be possible to make the distribution of the daily forecast of the Weather Bureau coextensive with the rural free delivery itself. The distribution of forecasts by this means alone would require not less than 450,000,000 blank forms for the routes that will be in operation on July 1, 1903. The purchase of these forms, together with the necessary printing appliances and the employment of the assistance required, will cost, it is estimated, not less than $100,000.

EQUIPMENT AND INSPECTION OF VOLUNTARY STATIONS.

The inspection of voluntary stations was undertaken on a more extensive scale than in any previous year in the history of the Bureau, and for the first time an allowance for this purpose was made to each section, $1940 having been apportioned among the several sections according to their needs. It became necessary, however, before the end of the year to cancel the authority to use the unexpended balances on account of the uncertainty of being able to continue the inspections under the conditions prescribed. All amounts not used, therefore, by May 15 were turned in to be applied to other purposes for which the Bureau had urgent need. Less than $600 of the amount allotted for the inspection of stations was used; but with this comparatively small amount 268 stations were inspected, at an average cost of $1.94 per station. The experience gained during the year in this line will prove of decided advantage in the following year, for which an increased allowance has been made and all of which will doubtless be expended.

While 230 new voluntary stations have been established, the total number at the close of the year was but little greater than at the end of the preceding year, as 209 stations were discontinued. Efforts have been mainly directed toward the improvement of the equipment and exposure of instruments at stations already established rather than toward an increase in the number of stations. A very gratifying improvement in the character of the observations has followed. There can be no doubt that the voluntary observers of the Bureau, as a rule, now more thoroughly understand their duty and perform the same with more painstaking care than ever before. A large number of thermometers of various makes have been replaced by the standard tested instruments of the Weather Bureau, and many rain gages not of the Weather Bureau pattern have been replaced by those corresponding to the regular station equipment. In the work of establishing new voluntary stations and improving the equipment of those already established there have been issued during the year 607 maximum thermometers, 388 minimum thermometers, 313 thermometer shelters, and about 200 rain gages.

COTTON AND SUGAR AND RICE SERVICES.

Four cotton-region stations have been discontinued and 18 established, 7 of the new stations being placed in the important cotton fields of Texas. These new stations constitute a valuable addition to the cotton-region service. The increase is highly appreciated by those interested in cotton. The number of sugar and rice region stations remains unchanged, there being 8 such stations. The total number of cotton and sugar and rice stations at the close of the year was 148.

CORN AND WHEAT SERVICE.

Two new stations were established and none discontinued, the total number being 133.

CALIFORNIA FRUIT AND WHEAT SERVICE.

This service was inaugurated during the latter part of the previous year, at the close of which there were 8 stations. The period covered by the reports extends from June 1 to August 31. Before the resumption of the service for 1902, 12 new stations were established, the total number now reporting being 20. This service has proved very popular; it supplies information of much value to the fruit and wheat interests of California. Daily bulletins are issued by the official at San Francisco giving the maximum and minimum temperatures and rainfall for the series of stations, the bulletins being identical in character with those of the corn and wheat and cotton region services.

CLIMATE AND CROP PUBLICATIONS.

The standard of the monthly section reports has been fully maintained, and in some instances improved. The value of these is now more fully recognized, and the demand for them is constantly increasing. These reports are issued with promptness, and it rarely occurs that a section bulletin is not issued before the close of the month succeeding that for which it forms the record.

The weekly climate and crop bulletins are in greater demand than at any previous time. No material change has been made in the form of the bulletins issued by the several sections. The editors of agricultural and commercial papers avail themselves largely of these bulletins.

Recognizing the importance of preserving the section publications in the most careful manner, nearly $1500 was expended during the year in binding at each center a complete file of all the section reports issued by the several sections. We have now, therefore, at every climate and crop center, bound in substantial manner, a complete file of the reports of each and every section, so that every climate and crop-service section center is prepared to place at the disposal of inquirers detailed climate and crop information from every part of the United States.

THE WEATHER SERVICE IN CUBA.

The work that the Weather Bureau has carried on in Cuba may be divided into two classes:

(1) The climate and crop service, which is concerned with Cuba alone.

(2) The storm-warning service, of which the observation stations in Cuba form only a part of the general system operated primarily for the benefit of the commerce of the Gulf and South Atlantic coasts and the West Indies.

The Cuban section of the climate and crop service of the Weather Bureau has been turned over to the secretary of agriculture of the Republic of Cuba. It consisted of 25 voluntary observation stations, each one of which was equipped with a set of thermometers, a rain gage, an instrument shelter, and the necessary forms for the rendering of reports; it had also 86 crop correspondents.

The voluntary observers and the crop correspondents reported to Havana and gave to the section director the data that enabled him to publish a monthly climatological report of the island and a weekly bulletin showing the condition of crops in the various provinces.

That portion of our storm-warning service located on the island of Cuba consists of an observatory at Havana, one at Cienfuegos, one at Puerto Principe, and one at Santiago. The protection of our own seaports on the Gulf and South Atlantic coasts against the approach of West Indian hurricanes renders it desirable to have a few observation stations on the island of Cuba.

A mutually beneficial cooperation has been proposed, whereby the Republic of Cuba might be given the benefit of our extensive system of cable-reporting stations in return for the privilege of maintaining the four stations hereinbefore referred to.

In accordance with the request of the Cuban Government, the Weather Bureau is still making forecasts for the island and cabling them to all of the commercial ports of the Republic. These warnings can only be made by some official having daily access to the extensive system of observations collected by the United States Government from the islands and mainland around and about the Gulf of Mexico and the Caribbean Sea.

Observations taken only on the island of Cuba would not cover an area of sufficient extent to render possible the making of the most accurate warnings. The Weather Bureau has in its possession the necessary data on which the most reliable forecasts and warnings for Cuba can be made, and has been glad to render this service to the Cuban Government.

THE MONTHLY WEATHER REVIEW.

The MONTHLY WEATHER REVIEW has been published as regularly as practicable, but the number for the month of April, 1902, was kept waiting in order to include therein an important memoir on "Rainfall and charts of rainfall," illustrated with a special edition of the relief map of the United States, furnished by the cooperation of the United States Geological Survey. The REVIEW for the month of May was also delayed for about two weeks in order to include therein a plate of the bolograph spectrum furnished by the kindness of Prof. S. P. Langley, Secretary of the Smithsonian Institution. The July REVIEW appeared on time.

As the MONTHLY WEATHER REVIEW continues to be recognized as an important medium for the diffusion of information relative to results of work in all branches of climatology and meteorology, no pains have been spared to make it a credit to the Government. The general appearance of the REVIEW has been improved by the introduction of new type and a quality of paper that allows the insertion of illustrations in the text, thereby diminishing the general cost of printing. At my request the Editor has prepared a brief statement of the articles most important to meteorological science that have appeared during the past year. Special mention is made of the following:

(1) Byron McFarland: "The thunderstorm—a new explanation of one of its phenomena." In this the author maintains that the descending mass of cool air accompanying the rain, by reason of its greater density and pressure, causes the sudden rise in the barometer that generally accompanies a thunderstorm.

(2) Marcel Brillouin: "Historical introduction to his collection of original memoirs on the general circulation of the atmosphere." This is an excellent critical review of important publications on the movements of the atmosphere. The author especially enforces the necessity of studying the atmosphere in connection with the real surface of the earth, and not the ideal uniform globe that is generally considered by mathematicians.

(3) Frank W. Very: "The solar constant." This is an admirable review of the present state of our knowledge of the amount of heat received by the atmosphere from the sun, and the amounts absorbed and radiated by the air. Professor Very also gives some fundamental suggestions as to the method of investigating this subject, which is so important to meteorology. This article has been very favorably noticed by European reviewers.

(4) H. H. Kimball: "Ice caves and frozen wells." This embodies the results of a personal examination of several cases in which ice is formed and preserved under ground. Mr. Kimball gives a satisfactory general explanation of the meteorological conditions necessary to this formation of ice, showing that, in general, caves, wells, and porous ground are cooled by the percolation of cold air to such an extent that the cold ground will freeze any water that may subsequently flow into it. He cities cases of stalactites and stalagmites of ice in deserted iron mines. Taken in connection with the exhaustive descriptive work by E. S. Balch, of Philadelphia, we have now a very satisfactory idea of the process by which ice caves, ice beds, and frozen wells are formed throughout the world, and the former hypotheses, especially that which referred them back to the Glacial age, must now be abandoned.

(5) H. H. Kimball: "The general circulation of the atmosphere, especially in the Arctic regions." In this memoir, which was a thesis for the degree of M. S., the author shows the great contrast between the theories of Ferrel, Oberbeck, and Helmholtz on the one hand, and those of Bigelow and Teisserenc de Bort on the other. He then collects and charts all available observations of the movements of the highest cirrus clouds in northern latitudes, and shows that they demonstrate the existence of a rather weak movement of the surface wind westward for latitudes north of 65°, with modifications introduced by the low barometric pressures in the North Atlantic and Bering Sea. It is probable that these modifications are appreciable, because in northern latitudes the cirri are low down, and above these there should be a stronger current from the west eastward.

(6) C. F. Marvin: "The measurement of sunshine and the preliminary examination of Ångström's pyrheliometer." This paper not only introduces Ångström's electric compensation pyrheliometer to the attention of American physicists, but shows how it can be best used to advance meteorological research. Three copies of this instrument have been purchased by the Weather Bureau and carefully compared before being intrusted to the hands of the respective observers. Professor Marvin's paper gives the results of these comparisons, from which it appears that the amount of heat received from the sun per minute, per square centimeter, by a surface normal to the solar rays and outside of the earth's atmosphere, is about 3.1 gram calories, and that measurements made at sea level are liable to an uncertainty of about 1 per cent.

(7) O. L. Fassig: "The westward movement of the daily barometric wave." This is a short article accompanied by important charts, showing that the principal features in the diurnal curve of local variations of barometric pressure move westward around the globe daily.

(8), (9) Mark S. W. Jefferson: "The reduction of records of rain gages." This article calls attention to the unsatisfactory condition of our knowledge of the distribution of rainfall. The author suggests certain modifications in the methods of preparing rainfall charts. As this subject is of the greatest interest in relation to agriculture, irrigation, engineering, and general meteorology, correspondence was invited on this subject. Professor Abbe prepared an extensive "symposium" on "Rainfall and charts of rainfall," which appeared as a supplement to the MONTHLY WEATHER REVIEW for April, 1902. In this symposium the latest rainfall charts by Prof. A. J. Henry, of the United States Weather Bureau, for the years 1871–1901, inclusive, and by Mr. Henry Gannett, of the United States Geological Survey, for the years 1871–1893, appeared, accompanied by a relief map of the United States, which must be studied in connection with the rainfall. The correspondence and extracts published in this symposium explain the methods of preparing rainfall charts, and show some of the errors of those who would apply hypothetical corrections for altitude, or would, from the presence of forests and lakes, infer a special increase of rainfall. The whole discussion emphasizes the extreme importance of a large increase in the number of our rainfall stations, in order that the Weather Bureau may satisfactorily respond to the general public demand for information as to rainfall and snowfall.

(10) Maxwell Hall: "The sun-spot period and the temperature and rainfall of Jamaica." In this paper the author shows that since 1883 there has been a close parallelism between the mean maximum temperatures at Kingston and the curve of sun-spot numbers. There is also some show of parallelism between this sun-spot curve and that of the general rainfall for Jamaica.

(11) A. Wolfer: In order to facilitate the study of solar relations Professor Abbe reprinted in the MONTHLY WEATHER REVIEW for November, 1901, the complete table of "Wolf's relative sun-spot numbers." This led to a correspondence with Prof. A. Wolfer, of Zurich, who stated that, as the successor to Professor Wolf, he had undertaken to revise the original series of sun-spot numbers and incorporate all newly discovered data. This revision was therefore published with some remarks by Wolfer in the MONTHLY WEATHER REVIEW for April, 1902, simultaneously with its publication in Switzerland. This constitutes a most welcome addition to our knowledge of sun-spot phenomena, and while, on the one hand, it will undoubtedly stimulate research into the relations between the sun and the earth, it will, on the other hand, serve to refute many erroneous hypotheses and bring us nearer to the truth.

(12) Albert Matthews: "Indian summer." This is the result of an exhaustive examination of the literature of England and America; the author shows that the term Indian summer first appears in 1794, at which time it was probably in general use throughout the United States. This memoir has excited very general commendation, coupled with expressions of surprise at finding that we know so little about the origin of the term and the reason for its adoption.

(13) S. P. Langley: "The Astrophysical Observatory of the Smithsonian Institution." In this article Professor Langley first describes his bolometer and his laborious, but successful, efforts to secure a bolograph made by automatic methods. The article is illustrated with a remarkably fine reproduction of Langley's original bolograph spectrum. The author calls attention to the important meteorological bearings of his studies with the bolometer. That, in fact, our seasonal weather changes and probably also the irregularities of climate from year to year are dependent upon the absorption of solar heat by the carbonic-acid gas and the aqueous vapor in the atmosphere. The absorption is greatest in Washington in August. Similar results have been attained with the actinometer of Crova at Montpellier, and, especially, by the visual observations of aqueous absorption lines in the spectrum, as conducted by L. E. Jewell at the Johns Hopkins University and published in 1896 in Bulletin 16 of the United States Weather Bureau. There can, therefore, no longer be any doubt that by means of these instruments meteorologists at sea level will be able to gage the average and the special absorptive powers of the atmosphere above them. The bolograph and actinometer must, therefore, form an important adjunct in every important meteorological observatory.

(14) F. H. Brandenburg, W. V. Brown, and Prof. E. B. Garriott: "On the classification and index of weather maps and weather types as an aid to forecasting." These three articles on this subject have shown practicable methods of obtaining an end that is greatly to be desired. Professor Garriott especially calls attention to the fact that types of formations and movements of the same general character, extending over periods of several days, are much more important than types of individual weather maps or weather conditions. It is to be hoped that the great importance of this subject will stimulate further efforts in this line, but they will hardly attain complete success unless they are carried out in sympathy with correct views of the general circulation of the atmosphere. It is this latter question that offers the fundamental difficulty in all weather forecasting, and especially in long-range forecasts. An article in the December REVIEW, "The physical basis of long-range forecasts," explains the general character and difficulties of the problem in popular language, and suggests an appropriate method of treating the general circulation of the atmosphere, as disturbed by the presence of land and water on this globe. But the most important work on this subject is that of Professor Bigelow mentioned below.

(15) Prof. F. H. Bigelow: "Studies on the statics and kinematics of the atmosphere of the United States."

Paper I. "A new barometric system for the United States, Canada, and the West Indies."

Paper II. "Methods of observing and discussing the motions of the atmosphere."

Paper III. "The observed circulation of the atmosphere in high and low areas."

Paper IV. "Review of Ferrel's and Oberbeck's theories of the local and general circulations."

Paper V. "Relations between the general circulation and the cyclones and anticyclones."

Paper VI. "Certain mathematical formulæ useful in meteorological discussions."

This series of papers, published in the MONTHLY WEATHER REVIEW for January–June, 1902, are important contributions. They constitute a complete summary of Professor Bigelow's researches into the physics of the earth's atmosphere and also give us a general idea of nearly all that has thus far been accomplished in this field of work. This study involves a knowledge of the conditions prevailing at and above ordinary cloud levels; therefore, the author has discussed the movements of the atmosphere, the formation of clouds, the temperatures and moistures observed by the highest balloon ascensions. He not only summarizes all the work that is published in detail in his International Cloud Report and his System of Barometry, but he prepares the way for a proper reduction of the observations of temperature, moisture, and wind made at Weather Bureau stations and for drawing daily weather maps for several successive levels in the atmosphere. He finds that with increasing altitude above 10,000 meters the rate of diminution of temperature steadily diminishes, but recognizes that the accurate measurement of the temperature of the air in the highest strata is a very difficult process, and that all efforts to secure reliable results deserve the hearty support of meteorologists.

Among the most important papers accepted but still awaiting publication in the MONTHLY WEATHER REVIEW are the two following:

(1) W. A. Bentley: "A report on photomicrographs of snow crystals secured during the winter of 1901–2." For twenty years Mr. Bentley has devoted himself to the study of snow crystals. His collection of photomicrographs taken in Jericho, Vt., surpasses the sum total of all that has been done by all others in the world, and must form the basis of all future study into the reasons for the great variety of forms that occur. It seems likely that each snowflake contains within itself traces of the processes that it has had to undergo in its journey from the clouds to the earth. Therefore the crystals should tell us of the atmospheric conditions in the regions whence they came. From this point of view it is evidently important to encourage Mr. Bentley in his labor of love. It is to be hoped that a physicist of sufficient ability may be found to associate himself with Mr. Bentley in this work and to carry it on to a successful conclusion.

(2) J. W. Sandström: "On the construction of isobaric charts." This memoir has been prepared under the general supervision of Prof. V. Bjerknes, of the University of Stockholm, and is believed to present important novelties in practical meteorology. Mr. Sandström has made special use of the splendid series of observations in the free air obtained by the Weather Bureau by means of the Marvin kite and meteorograph, during the summer of 1898. It seems likely that his studies, taken in connection with those of Professor Bigelow, will indicate the proper

method of utilizing daily records from kites and balloons as supplementary to observations of the clouds by means of the nephoscope. Mr. Sandström's memoir was written in German, and is now being translated by Professor Abbe for publication.

Professor Abbe states that his duties as dean of the scientific staff and editor of the MONTHLY WEATHER REVIEW have been greatly lightened by the valuable assistance of Mr. H. H. Kimball as assistant editor of the REVIEW.

The recent publication of the important "Lehrbuch der Meteorologie," by Prof. Dr. Julius Hann, of Vienna, marks an important epoch in the history of meteorology. It constitutes a fairly complete summary of the present condition of our knowledge in all branches of observational meteorology, with many valuable suggestions as to theories and explanations of the phenomena. Professor Abbe has continued the translation of this work as rapidly as other duties would permit; but it is a large undertaking and can not be finished within the coming year.

CARNEGIE INSTITUTION.

The establishment of the Carnegie Institution for research has led the trustees to address the Chief of the Weather Bureau a general request for suggestions as to what this institution can do for meteorology, and the board of research appointed by the Chief of Bureau has duly reported on the subject. The trustees of the Carnegie Institution have requested Professor Abbe to act as their general adviser on matter pertaining to meteorology. The Chief of Bureau's report to the trustees, as also that of Professor Abbe, takes very much the same view of the subject; that is, that the Carnegie Institution should occupy those fields of research that are outside of the official duties of other institutions, but should cooperate with them as far as possible.

AERIAL RESEARCH.

There has been inaugurated a programme of aerial research in the upper strata of the atmosphere. Professor Abbe has been given charge of this work, with the privilege of calling upon Professors Marvin, Bigelow, and others for assistance. The first duty in connection with this work has been to correspond with manufacturers of hydrogen and with instrument makers and special aeronautic experts in the United States and Europe, in order to ascertain what is at present considered practicable and best. There is every prospect that we shall be able to send up some sounding balloons with meteorographs during the coming year. Meanwhile the most laborious part of the preparatory work falls upon Professor Marvin and will take nearly all of his time for six months to come.

SOLAR HEAT AND ATMOSPHERIC ABSORPTION.

In July, 1901, the Bureau received three copies of Ångström's Electric Compensation Pyrheliometer, which instrument is intended to measure in calories the amount of heat received by radiation from any distant source, including, of course, the sun. It is intended to use these three instruments in carrying out researches on the amount of solar heat and of atmospheric absorption and allied questions. One of them is kept as a standard at the Weather Bureau and may be used in Washington; the others are now located, respectively, in Baltimore, in care of Prof. J. S. Ames, and the other in Providence, R. I., in care of Prof. Carl Barus. Numerous investigations must be carried on by these physicists as preliminary to the main object of our research. Articles published in the MONTHLY WEATHER REVIEW by Prof. C. F. Marvin, Prof. F. W. Very, Mr. C. G. Abbott, and Prof. S. P. Langley have given a general idea of the scope that the investigation must take.

BAROMETRY.

The work on the barometry of the United States and Canada has been completed by Prof. Frank H. Bigelow, and the tables for the reduction to sea level have been in operation since January 1, 1902, with results which seem to be quite satisfactory. The work of preparing and checking the station tables for reductions to the 3500-foot and the 10,000-foot planes is complete, and the individual tables will be issued during July, to be expanded at the stations, so that they will be ready for use in the autumn, as soon as the atmospheric circulation begins to be vigorous.

NEPHOSCOPIC OBSERVATIONS.

A very valuable set of nephoscope observations in the West Indian Islands has been secured, beginning May, 1889, and extending to May, 1902, at 11 stations. The circulation of the atmosphere in the tropical zone has never been carefully mapped out, and these observations for the first time afford us the necessary data for discussing these problems. In view of the popular interest in the distribution of the ashes ejected from Mont Pelée and La Soufrière in May and June, it is very opportune that the prevailing currents of air in the upper strata should be accurately determined. The computations on this work have been begun. Similarly, nephoscope observations will soon be commenced in the Pacific and Plateau districts, in order to supplement those made in 1896–97 for the international commission.

VAPOR TENSION AND PRECIPITATION.

It has become necessary to discuss the Weather Bureau observations on vapor tension throughout the United States, in view of the fact that no attempt has ever been made to construct any normals, or to determine the seasonal variation of the precipitation as depending upon this element. These computations will necessarily involve a careful treatment of the wet and dry bulb temperatures and a consideration of the troublesome psychrometric problems that are involved.

LOSS OF LIFE BY LIGHTNING IN THE UNITED STATES.

In Bulletin No. 30 the information collected from all parts of the country during the past ten years has been brought together and summarized by Prof. A. J. Henry. It is shown in this publication that destructive lightning strokes occur with greater frequency in some parts of the country than in others; that the region of greatest frequency is in the Ohio Valley, the lower Lake region, and the Middle Atlantic States, and that, considering the sparsity of the population, the number of fatalities in the middle Rocky Mountain region and the upper Missouri Valley is surprisingly large. A study of the data has also enabled the Bureau to formulate a few simple precautions against danger from lightning stroke that are here reiterated:

It is not judicious to stand under or near trees during thunderstorms, in the doorways of barns, near chimneys and fireplaces, or timbers that lead directly to the room. Neither should one stand near the point of entrance of telegraph and telephone wires. (The latter should invariably be provided with lightning arresters and ground wires.) It is not advisable to huddle under wagons, thrashing machines, or under frame structures surmounted by a flag pole. A wire clothesline should not be attached to a dwelling house under any circumstances; rather suspend it between two neighboring trees or posts.

WIND VELOCITY AND FLUCTUATIONS OF WATER LEVEL ON LAKE ERIE.

Strong westerly winds on Lake Erie pile up the water in the harbor of Buffalo, at the eastern end of the lake, the rise in level at times being so great as to be detrimental to navigation and injurious to wharf property. The establishment under the direction of the Chief of Engineers, U. S. Army, of self-recording water-level gages in Buffalo Harbor and at the western end of the lake, and the hearty cooperation of that official with the Bureau, has made it possible for Professor

Henry to study the relations between the force and direction of the wind and sudden changes in the level of lake waters.

It was found that with westerly winds of velocities less than 50 miles per hour at the eastern end of the lake the changes of level in Buffalo Harbor were not great enough to menace navigation; when, however, the velocity of westerly winds passes beyond 50 miles per hour, wharf property is always more or less exposed to danger from flooding. The height to which the water will rise depends partly upon the strength, duration, and suddenness of the westerly winds and partly upon the season of the year. The winds of the warm season seldom prevail long enough to cause an overflow. It was also found that while the crest of the rise in lake level and the maximum velocity of the wind generally coincided in point of time, the water would begin to fall as soon as the crest was reached, regardless of the force of the wind, and that it would continue to fall and then rise again, in a series of oscillations up and down, until the normal level was restored.

The relations between the velocity of the wind and dangerous changes in water level seem to be sufficiently definite to attempt to forecast them for the benefit of local interests at Buffalo and the western end of the lake, especially the last named, where a knowledge of the changes in depth of water in the channel at the mouth of the Detroit River would be of great value to navigation.

CONVENTION OF WEATHER BUREAU OFFICIALS.

The triennial convention of Weather Bureau officials met at Milwaukee, Wis., August 27–29, 1901. There were in attendance one hundred of the directing officials of the Bureau, representing every section of the country and every branch of the weather service. The entire scientific staff, consisting of seven professors, was present and took part in the proceedings. The Secretary of Agriculture honored the convention with his presence just before its close, and in a few well-chosen remarks congratulated the convention on the achievements of the weather service and the high standard of its personnel. The citizens of Milwaukee gave the members of the convention and their guests a banquet at the Pfister Hotel on the evening of the last day of the convention. The banquet was presided over by Hon. E. C. Wall, president of the chamber of commerce. The Press Club of Milwaukee also generously entertained the convention at a reception one evening during its stay in the city.

Much work valuable to the Government service was accomplished by this gathering together of the leading officials of the Bureau. The report of the convention has been printed as Bulletin No. 31. It comprises 250 pages and contains all of the papers read before and discussed by the convention. This report will be read and studied by the officials of the Bureau who were not in attendance at the convention. By thus printing and disseminating a complete report of the convention the younger observers and officials of the Bureau are given nearly as much benefit as though they had been in attendance. The printed report contains so many valuable papers and discussions that it will be found of great interest to many who are interested in meteorological problems and who are not connected with the Government. The esprit de corps and the devotion to their chosen profession of the officials of the Weather Bureau are well shown by the fact that, although it was required that they bear the expense of attendance upon the convention, except for transportation, practically all of the prominent officials of the Bureau were in attendance, and many others were anxious to go who could not be spared from their official duties.

WIRELESS TELEGRAPHY.

Experiments in space, or wireless, telegraphy were begun January 1, 1900, in accordance with the orders of the Secretary of Agriculture, and carried on under the direction of the Chief of the Weather Bureau. Prof. R. A. Fessenden was placed in immediate charge of the work and continued in that capacity until July 30, 1902, when he was succeeded by Mr. A. H. Thiessen.

While much valuable information has been secured and a fairly satisfactory experimental system has been devised, I am not able to report such progress in the investigation as would justify the Department in dispensing with its coast telegraph lines or the cables that connect certain islands with the mainland.

The hot-wire receiver, or boloscope, was found to be the most sensitive of any yet used in the experiments. Its action was positive, and during the early spring it gave excellent results; messages were transmitted with a rapidity almost equal to that of the ordinary telegraph. Quite satisfactory tests were made before a board from the Army and one from the Navy. It was thought that the Bureau had finally devised a receiver that would take the place of all others in use; but as the season advanced into summer and unstable atmospheric electrical conditions became more frequent it was found that the minute platinum loops on which the active principle of the boloscope depended would frequently burn out after connection was made with a vertical wire.

It has so far been found impossible to send messages any appreciable distance over land or fresh water or to attune the transmitter to the receiver so as to overcome the difficulties of interference should a second transmitter generate electric waves within the same field.

I am of the opinion that the use of wireless telegraphy in its present state is limited to the transmission of messages between moving ships and between ships and the land, and that wherever permanent communication is required the cable or the land wire is the more reliable means of communication and probably the more economical.

Our experiments during the past year were conducted over a course between Manteo and Cape Hatteras, N. C., a distance of about 50 miles.

INSTRUMENTS.

STATION EQUIPMENTS.

Nearly all stations are now fully equipped with automatic instruments recording wind velocity and direction, the temperature and pressure of the air, and the duration of sunshine and rainfall. The extensive and thorough inspection of stations that has been made within the last two years has resulted in numerous recommendations by the inspectors, which, in the main, have been carried out and which have necessitated the replacing of old automatic apparatus with that of the most approved type. We have been obliged to postpone the equipment of some stations already listed to be supplied, but it is expected that these will receive attention during the next few months.

It is considered, in the present connection, that a station is fully equipped with automatic instruments whenever records of the following meteorological conditions are continuously and automatically produced, namely: Wind velocity, wind direction, temperature, pressure, rainfall, duration of sunshine.

On June 30, 1902, there were in operation 191 stations at which at least one meteorological element was automatically recorded, and in order to set forth graphically the present status of the equipment of stations, these may be separated into the following classes:

(*a*) Stations completely equipped as defined above	124
(*b*) Stations awaiting equipment as supplies become available	24
(*c*) Stations maintained by agents where the equipment is necessarily simple and hence incomplete	9
(*d*) Special display or other stations, at which records of some particular element, generally wind velocity only, is desired	17
(*e*) Regular stations now partly equipped, but which are of small importance, or so circumstanced that further additions to the present equipment are not considered desirable or necessary	17
Total	191

(*f*) New stations announced but not yet established.

In connection with the 124 stations quoted as completely equipped, it should be remarked that in addition to the automatic registers and apparatus constituting a complete equipment, 105 of the 124 stations are provided with a special so-called instrument stand, on which the automatic registers are installed to advantage, including an extra anemometer, a whirling apparatus, maximum and minimum thermometers, and a glass sunshine recorder, all arranged to exhibit these devices to visitors, etc. In order to still further improve the equipment and furnishings of stations, a series of 26 climatic and meteorologic charts were prepared and printed and sets issued to stations about two years ago. Some of these were bound, some framed separately and hung up on the walls of the offices, but finally during the past year a special set of swinging frames of ornamental pattern was designed, and about 79 stations have thus far been supplied with them. Stations with ample wall space have displayed the charts in separate frames. There are about 20 stations of this number at which 15 or more of the charts are so displayed (in wall frames). We thus have 124 stations completely equipped with automatic instruments, and the greater part of them provided in addition with special instrument stands, framed climatic charts, and extra instruments arranged for exhibit. It must be noticed that of those not equipped with instrument stands, charts, etc., many, such as the West Indian stations, for example, and some in the United States, do not really require or can not use this part of the standard outfit.

Referring again to the classified list above, it appears that if we exclude classes (*c*), (*d*), and (*e*), the stations of which do not require further equipment, and class (*f*), which pertains to the future, there remain 124 stations of the Bureau now fully equipped and 24 stations in process of equipment.

On the whole, it may be stated that the latter are now about one-half equipped; that is to say, about twelve complete sets of apparatus will be required to complete the equipment. It is confidently expected that the entire equipment at all stations will thus be completed during the current fiscal year.

STORM-WARNING EQUIPMENT.

The work of extending the equipment of steel towers and high-power lanterns of improved type at important storm-warning stations has also constituted an important piece of work assigned to the Instrument Division, which is directed by Professor Marvin, and this was pushed energetically during the year, as far as funds would permit. In all, 54 towers have been distributed to storm-warning stations, of which number 4 were to regular stations for special purposes. Of those issued, only 3 have not yet been erected, owing to unavoidable delays in procuring satisfactory sites and the exorbitant nature of bids for erection.

The funds available for this work during the past year were too limited to permit of the purchase of the high-power lanterns and certain other accessories required with the towers, hence none were provided. Moreover, the first six months of the past year have been mostly consumed, of necessity in the manufacture, shipment, and installation of the towers, hence the plan was adopted of spending the sum available mostly for towers and their installation, leaving the matter of lanterns and accessories to be supplied this year. Provision for this has already been made, but the storm-warning fund will permit of no considerable extension of the work beyond finishing matters left over from last year.

There are now 109 storm-warning and 9 special stations at which the steel towers have been installed. Of these, 48 now need lanterns, which will be issued as soon as delivered by the contractor.

TESTING AND ADJUSTING INSTRUMENTS.

This important work has grown to very great proportions with the large extensions of the service during the past few years.

All automatic instruments and registers, not only new instruments, but old ones that have been repaired, are most carefully tested in actual work and adjusted before the instruments are put in operation at stations. But few of the observers have that intimate knowledge of the theory of all these apparatus or the skill that is required to set in order instruments that may be generally out of adjustment. This delicate and important work is performed, under the direction of Professor Marvin, in a most conscientious and intelligent manner by Mr. Charles B. Tuch, whose skill and long experience with meteorological apparatus renders his service of the greatest value.

The comparison of thermometers likewise involves a large amount of painstaking, technical work. During the year about 1400 thermometers were inspected and compared. The temperatures at which comparisons are made range from 40° below zero to 112° above, and thermometers are compared at points every 10° along the scale, with the exception of maximum thermometers, which are not compared at points below 32°. This means at least nine readings on every thermometer and four to six additional readings at low temperatures on all mercurial and alcohol thermometers, making an average of about thirteen readings for each thermometer. This work and that of deducing and tabulating the corrections from the thousands of readings involved is performed in the most satisfactory manner by Mr. Samuel A. Potter.

It is only by such a rigid system of inspection, testing, comparison, and adjustment of instrumental apparatus that a high standard of reliability can be maintained, and it may fairly be affirmed that the instruments of the United States Weather Bureau are unsurpassed in respect to their uniform excellence and accuracy by similar instruments anywhere.

MACHINE SHOP.

During the past year the old, antiquated foot lathes, formerly constituting the entire equipment of our repair shop, were replaced by new power-driven lathes and some other machinery.

The repair work on instruments fell considerably in arrears during the period of transition from the old to the new machinery, not only because of the time required in the installation and refitting of the shop, but from the fact that the complete utility of the new machinery depends upon securing a multitude of special tools, cutters, dies, jigs, etc., suited to the particular work in hand; and a great deal of time was expended in the construction of such special tools, Therefore the full value of our improved equipment will only be realized as these special accessories multiply and become more varied with continued work.

For many years we have had but two skilled mechanics in the machine shop, and in the meantime the number of complex automatic instruments at stations has increased from 10 or 15 pieces for the entire service to about 800 now in actual use throughout the service. Some of these are exposed to all degrees of weather conditions, and all are subject to more or less deterioration and wear with use. An increase in the force of skilled mechanics is much needed, in order to properly keep up the repair work on the great number of instruments now in use.

INSTRUMENTAL RESEARCH WORK.

The routine operations of the Instrument Division have so wholly absorbed the time, thought, and energies of Prof. C. F. Marvin, the able chief of the division, and the persons engaged therein as to leave them little opportunity for serious application to the many unsolved technical problems involved in the construction and operation of meteorological apparatus. In former years the volume of routine work was much smaller and less exacting than at present; but we earnestly look forward to a time in the near future when the burden of routine duties shall diminish because of the completed state of the

instrumental and storm-warning equipments. Then our experts will be able to devote at least a portion of their time to special problems.

Professor Marvin expresses high appreciation of the conscientious application and ability with which Mr. D. T. Maring, the assistant chief of the instrument division, has assisted him.

OBSERVATORY BUILDINGS.

In the act making appropriations for the Department of Agriculture for the fiscal year ended June 30, 1902, approved March 2, 1901, Congress included an item for the purchase of a site and erection of a small brick and wooden building at each of the following-named stations for the use of the Weather Bureau, at the amounts set opposite each, viz: Atlantic City, N. J., $6000; Hatteras, N. C., $5000; Fort Canby, Wash., $4000; Port Crescent, Wash., $3000; Tatoosh Island, Wash., $5000, and Point Reyes, Cal., $3000; and for the purchase and laying of a cable between the mainland and Tatoosh Island, Wash., including general repairs to telegraph line from Port Crescent to Tatoosh Island, Wash., $20,000; in all, $46,000, with the proviso that if any of the money for these several buildings and cable remained unexpended it might be used in the repair, improvement, and equipment of the buildings owned by the Government and occupied by the Weather Bureau at Cape Henry, Va., Bismarck, N. Dak., Kittyhawk, N. C., and Jupiter, Fla.

Under this authority the work was immediately taken up by the Weather Bureau, and the following buildings were erected during the year at the total cost set opposite each, viz:

Atlantic City, N. J	$6,000.00
Hatteras, N. C	5,000.00
Fort Canby (North Head), Wash	3,992.63
Port Crescent, Wash	1,000.00
Tatoosh Island, Wash	4,950.00
Point Reyes, Cal	2,989.90
Total	23,932.53

In addition, the following buildings were also repaired, improved, and equipped, and supplies purchased therefor at the total cost set opposite each, viz:

Bismarck, N. Dak	$7,064.14
Jupiter, Fla	3,358.00
Kittyhawk, N. C	125.00
Cape Henry, Va	5,104.25
Supplies, instruments, etc	1,647.64
Total	17,279.03

In regard to the above, however, it may be proper to add that the buildings at Port Crescent, Wash., and Jupiter, Fla., are still in course of construction, but it is expected that they will be completed within the next three months.

It was deemed advisable not to lay a cable between Tatoosh Island and the mainland, Wash., but instead to build a span wire across, in order that the balance of the money thus created might be used in the repair and improvement of the buildings above mentioned. General repairs, however, are now being made to the telegraph line from Port Crescent to Tatoosh Island, Wash., at an approximate cost of $3000, which leaves a balance of about $1768.44 to be covered into the Treasury. Only such portion of this special appropriation has been expended as has been absolutely necessary for the work in question, and while the unexpended balance can be used for the purchase of supplies for any of the buildings named, I have felt it my duty not to incur any additional expense against this fund, as I believed that the buildings in question were sufficiently well equipped to meet the needs of the Weather Bureau.

The press has spoken in high terms of the benefit that the buildings will be to the marine and other interests.

In view of the complimentary criticisms from the public and the economy to the Government in owning its own buildings, thereby saving the amounts now paid for rent of office quarters, I recommended that an additional appropriation of $50,000 be asked from Congress for the purchase of sites and the erection of not less than six buildings during the fiscal year ending June 30, 1903, which you approved, and Congress has made an appropriation of the amount named. The places that have been selected for these new buildings, with your approval, are Yellowstone Park, Wyo.; Amarillo, Tex.; Modena, Utah; Key West and Sand Key, Fla., and South Farallone Island, Cal. There has been some difficulty in providing sites for the buildings at Modena and Amarillo, and it is not believed that it will be practicable to erect these buildings before next spring.

LIBRARY.

No change has been made in the ordinary routine of the library. The facility with which the library can be consulted has been greatly enhanced by the completion of the transcribing of the author index on cards of better size (standard library). Work has been begun on a subject index, a most important adjunct to a library, and one the need of which has been acutely felt for years past. No unforeseen interruption occurring, this much needed index should be completed within the current fiscal year. Conjointly with this subject index of books, author and subject indexes of the meteorological contents of the periodicals currently received have also been started. Bibliography is imperative in scientific research, and as soon as the present exigencies admit, more attention will be devoted to the subject of meteorological bibliography. An endeavor will be made to close the hiatus between the suspension of our bibliographic work some ten years ago and its partial resumption within the last year.

The number of volumes in the library has been increased during the year by 782 accessions, most of which are meteorological reports of other weather services. Many of these works can not be accommodated for lack of space, but remain in sacks and packages stored on the floor. Arrangements, therefore, will soon be made to assign additional room to the library. The Bureau now especially encourages the study of meteorology, not only in the public schools but also in the colleges and the universities of the country. This action is attracting the attention of teachers and students to the Central Office. It is a place for study; a place where the advantages of the collected data of the world may be obtained, and it is the only place of the sort in this country. In modern research work two instrumentalities stand out coequal and coimportant—library and laboratory—the library, from which to learn what other workers have thought and done; the laboratory, in which to test that which is newly thought out. The use made by our own officials of the library may be best shown by the fact that there are at present more than 550 volumes charged to and in use in the different divisions and sections of the office. No record has been kept of daily calls for books, but it is not improbable that more than a thousand books are taken out of the library for consultation annually. Having what we believe to be the largest and most complete meteorological library extant, it will be our aim to make it the most useful.

EXAMINATIONS.

There have been held during the year 71 examinations—36 of employees not previously examined in any branch, and 35 of employees who had passed the first-grade examinations and were taking the examinations prescribed for one or more of the other grades. It is believed that the purposes of the examinations would be greatly furthered if the questions as marked, together with the reasons for the marking, could be submitted to the examinee, and the supervising examiner has been instructed to do so in the future. To tell one that he is in error is necessary, but to tell one how he comes to be in error is more important—it is educative.

TELEGRAPH LINES.

No change has taken place since the last annual report in the total mileage (367 miles) of telegraph and telephone lines owned and operated by the Weather Bureau, no new lines having been built nor any old ones abandoned during the year.

No extensive line repairs have been needed except on the Tatoosh Island section, where general repairs are now underway, preparatory to the reestablishment of telegraphic communication with the new station about to be erected on that island. A wire span, supported on steel towers, is in course of erection between the island and the mainland, in lieu of a submarine cable which, as costly experience during past years has demonstrated, can not be economically maintained in that locality.

Nineteen nautical miles of two-conductor cable, laid by the Signal Service of the Army in 1898, between Block Island and Narragansett, R. I., were recently transferred to this Bureau. This cable has been out of working order since January. It was our purpose to recover it, replace the defective parts, and relay it so as to parallel our old Block Island cable for use in case of an accident to the latter. On taking it up it was found to be too badly worn to justify the expense of again putting it down, and an appropriation of $40,000 is recommended for the purchase and the laying of a new cable and the purchase of ground and erection of necessary buildings at each of the two termini.

The total "this line" receipts from commercial telegrams transmitted over Weather Bureau lines during the year were $2326.17, an increase of $597.68 over last year's receipts.

The total number of whole days and fractional parts of a day, respectively, on which telegraphic communication over Weather Bureau lines was interrupted is as follows:

From—	Whole days.	Fractional days.
Port Crescent to Neah Bay, Wash	10	55
San Francisco to Point Reyes, Cal	26	15
Edgartown to Nantucket, Mass	0	0
Block Island to Narragansett, R. I.	2	4
Norfolk, Va., to Hatteras, N. C.	5	47
Alpena to Middle Island, Mich.	1	6
Alpena to Thunder Bay Island, Mich.	0	0

Under acts passed by the last Congress, specifications and plans are being prepared for purchasing and laying about 50 statute miles (more or less) of submarine telegraph cables, to connect Sand Key, Fla., with Key West, Fla.; South Manitou Island, Mich., with Glenhaven, Mich., and the Farallone Islands, Cal., with San Francisco, Cal., via Point Reyes, Cal. A teredo-proof, one-conductor cable, with rubber insulation and twelve No. 8 guard wires, will be used for the Sand Key connection, and gutta-percha cables, with twelve No. 5 guard wires, for the others.

A short telephone line, to connect the new station at North Head, Wash., with the lines terminating at Fort Canby, Wash., is now under construction.

PUBLICATIONS.

The publications during the fiscal year may be summarized as follows:

TOTAL OUTPUT.

	Pieces.
Forecast cards:	
Manila	15,785,760
Paper	2,370,105
Station maps	4,087,792
Station forms, all kinds	2,738,130
Weather maps, Washington	539,772
Climate and crop bulletins	140,089
Monthly Weather Reviews	52,750
Lake charts	44,500
Snow and ice bulletins	31,043
Total	25,789,941

These figures relate only to work done within the Publications Division, and do not include miscellaneous printing for the Bureau done outside under authority of over 800 orders. They mean that 25,790,000 pieces, weighing more than 270 tons, were here printed, cut, bound or otherwise made into suitable packages, wrapped, and mailed.

WORK DONE AT THE GOVERNMENT PRINTING OFFICE.

	Pieces.
Forecast cards:	
Manila	13,000,000
Paper	13,000,000
Station maps	3,450,000
Total	29,450,000

These were also mailed to stations.

Other printing done at the Government Printing Office includes 2 quarto bulletins, aggregating 2700 copies; 7 octavo bulletins, aggregating 24,500 copies, and 625,000 miscellaneous forms.

To the above quantities are to be added 2,250,000 blank forecast cards, manila, shipped direct by the contractor to stations, and 2,000,000 paper forecast cards printed here previous to, but mailed after June 30, 1902.

ECLIPSE METEOROLOGY AND ALLIED PROBLEMS.

The track of the total solar eclipse of May 28, 1900, crossed the Southern States from New Orleans to Norfolk and afforded an unusual opportunity for studying some of the physical problems connected with the effects of solar radiation in the earth's atmosphere. The observations made in the eclipse track have been discussed by Prof. Frank H. Bigelow, and the results appear in Bulletin I, Weather Bureau, 1902, Eclipse Meteorology and Allied Problems. It is there shown what preliminary meteorological observations should be made for determining the position of eclipse stations. Professor Bigelow demonstrates that the so-called eclipse cyclone does not exist in the atmosphere; he also shows that the shadow bands are due to the light from the sun's crescent shining through the interstices of the mixture of currents of different densities that exist in the lowest layers of the atmosphere. A review of the scientific status of the problems of solar physics follows, in which the parallelism between the meteorology of the sun and that of the earth is indicated.

GENERAL CLIMATIC CONDITIONS.

By W. B. STOCKMAN, Forecast Official, in charge of Division of Meteorological Records.

ATMOSPHERIC PRESSURE.

The numerical values of annual mean pressures for 1902 are given in Tables I and VI. The departures are given in Table I.

The method of reduction of the observed pressures to sea level, standard gravity, and to the mean of 24 hourly observations is that adopted by the Bureau on January 1, 1902, and fully described on pages 13–16 of the MONTHLY WEATHER REVIEW for that month.

The sea-level values thus obtained are shown on Chart I.

The pressure on the 10,000-foot plane is also obtained as indicated on the same pages of the above-mentioned REVIEW, and the resulting isobars are shown on Chart II.

The mean annual barometric pressure was highest over Kentucky, Tennessee, the northern portion of the east Gulf States, and parts of the South Atlantic States, and lowest over the southern Plateau region. Except in parts of the central portions of Kentucky and Tennessee, and on the coast of cen-